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(54) Thermal imaging system

(57) A thermal imaging system links a dual waveband, dual magnification sensor 1 to a head steering system, using frame stores 2, 3 to store information from each sensor, and addressing the frame stores to supply to a helmet-mounted display 5 the correct thermal image depending upon the direction the user's head is facing, as indicated by the helmet position which is detected by sensor 8.

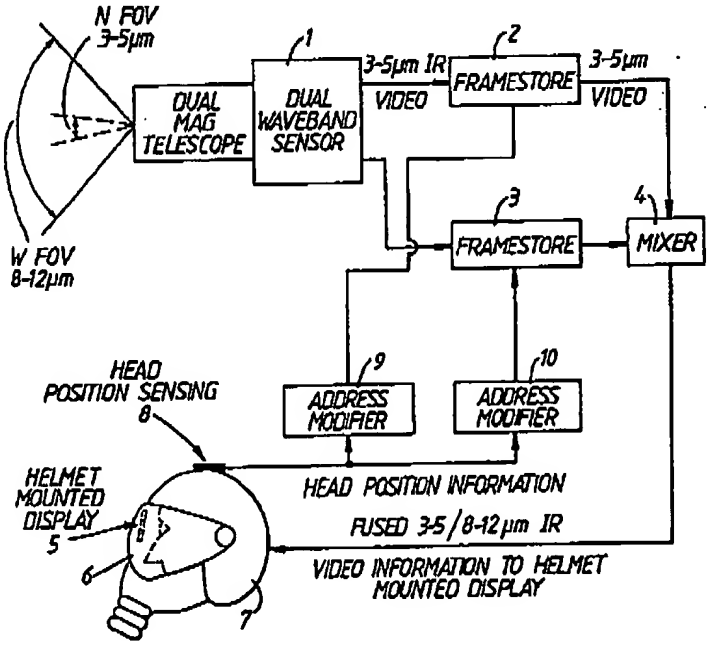


Fig.1.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

1/1

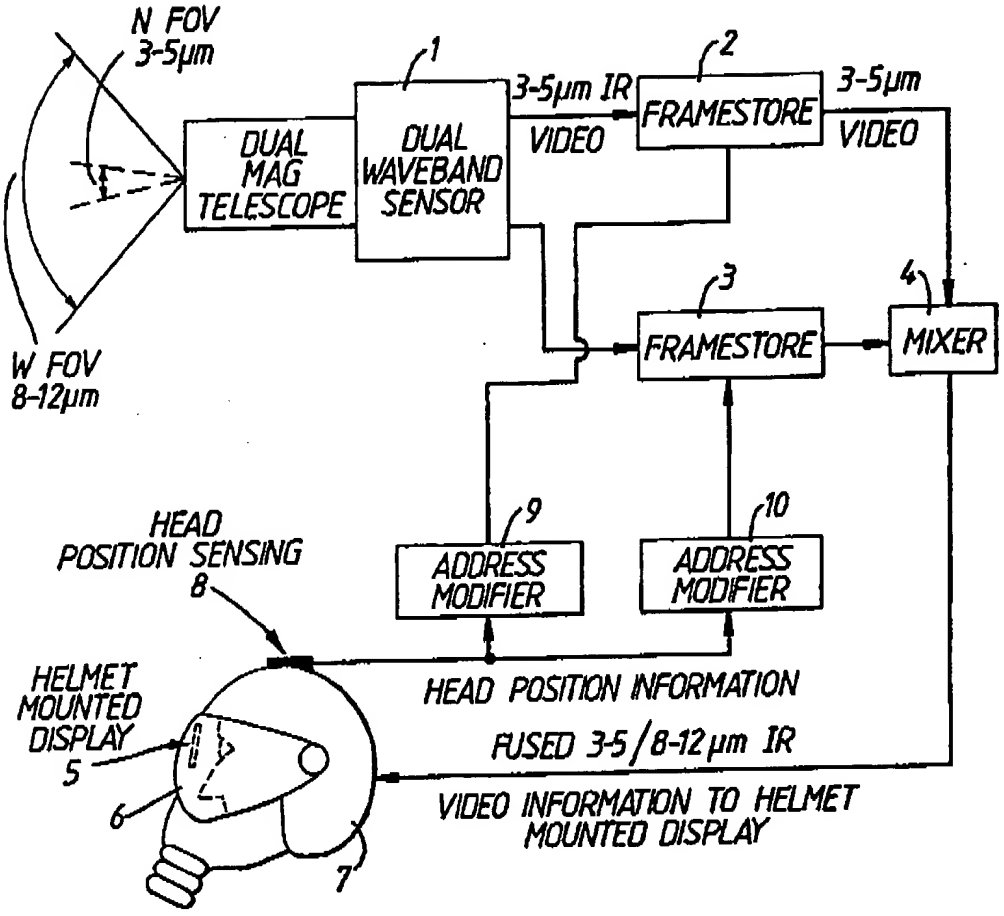
N FOV
3-5μm
W FOV
8-12μm
DUAL MAG TELESCOPE
1
DUAL WAVEBAND SENSOR
3-5μm IR VIDEO
2
FRAMESTORE
3-5μm VIDEO
3
FRAMESTORE
4
MIXER
9
ADDRESS MODIFIER
10
ADDRESS MODIFIER
HEAD POSITION SENSING
8
HELMET MOUNTED DISPLAY
5
6
7
HEAD POSITION INFORMATION
FUSED 3-5/8-12μm IR
VIDEO INFORMATION TO HELMET MOUNTED DISPLAY

Fig.1.

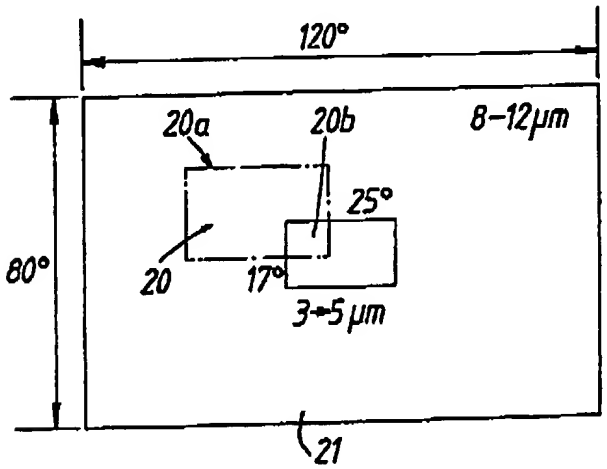
120°
8-12μm
20a
20b
25°
80°
20
17°
3-5μm
21

Fig.2.

# THERMAL IMAGING SYSTEM

This invention relates to a thermal imaging system.

In recent years there has been a drive to extend fighter aircraft utilization by equipping it to fly at night and in poor visibility. For example, a forward looking infra red sensor (FLIR) may be mounted on the aircraft, and a raster head-up display (HUD) used to display the resulting image. This arrangement offers the pilot simultaneous overlaid visual (through the HUD combiner glass) and thermal (on the HUD raster) images of the terrain ahead. The final element in this arrangement is to equip the pilot with night-vision goggles (NVG), thus giving him the all-important look-around capability to enable him to fly low and fast, using daylight flying techniques, at night and in poor visibility.

This arrangement has a number of limitations:

1. Just before dawn and just after sunset, there are periods of time when ambient light levels are too high to permit NVG operation, but too low to fly unaided;

2. Under certain combinations of moon phase, height above the horizon and aircraft flight path, NVG cannot resolve terrain features; and

3. Under high humidity atmospheric conditions, the FLIR image can be quite poor, as water vapour absorbs IR radiation in the 8 to 12μm waveband most commonly used by FLIR sensors.

Accordingly, one aspect of the present invention provides a thermal imaging system, comprising a wide angle thermal sensor providing an output signal representing successive image frames, means for temporarily storing information representing each frame in turn, means for superimposing on the field of view of a user an output image frame, means for detecting the position of the user's head and for selecting as the output image frame a portion of the stored image frame according to said detected position.

Another aspect of the invention provides a thermal imaging system, comprising a wide angle thermal sensor and a narrow angle thermal sensor, each providing an output signal representing successive image frames, the field of view of the narrow angle thermal sensor lying within that of the wide angle thermal sensor, means associated with each sensor for temporarily storing information representing each frame in turn, means for superimposing on the field of view of a user an output image frame, means for detecting the position of the user's head and for selecting as the output image frame a portion of one or both of the stored image frames according to said detected position.

A further aspect of the invention provides a thermal imaging system, comprising a wide angle thermal sensor and a narrow angle thermal sensor, each providing an output signal representing successive image frames, the narrow angle thermal sensor having a field of view directable within

that of the wide angle thermal sensor, means associated with each sensor for temporarily storing information representing each frame in turn, means for superimposing on the field of view of a user an output image frame, means for detecting the position of the user's head and for selecting as the output image frame a portion of the stored wide angle image frame according to said detected position, means for selecting as an alternative output image frame a portion of the stored narrow angle image frame according to the detected position, and means for switching between the alternative output image frames. The means for switching between alternative output image frame may comprise means selectively operable to combine the two alternative output image frames into a single output image frame. The narrow angle thermal sensor suitably comprises steering prisms for directing the field of view of the sensor in accordance with the detected position of the user's head.

The narrow angle thermal sensor is preferably sensitive to a different waveband to that of the wide angle thermal sensor. For example, the wide angle thermal sensor may operate in the 8 to 12μm waveband and the narrow angle thermal sensor may operate in the 3 to 5μm waveband.

The temporary storage means may comprise frame stores. Preferably, the means for superimposing an output image frame on the field of view of a user comprises a helmet-mounted head-up display. The means for detecting the position of

the user's head may then comprise means mounted on the helmet for providing a position signal to be detected by fixed means located near to the helmet. Alternatively, the means for detecting the position of the user's head may comprise detector means mounted on the helmet for detecting a position signal provided by fixed means located near to the helmet.

Reference is made to the drawings, in which:

Figure 1 is a schematic diagram of a system according to one aspect of the invention; and

Figure 2 is a diagram representing the fields of view of the two sensors in the system illustrated by Figure 1.

In the system shown in the drawings, a dual-waveband, dual magnification sensor 1 is capable of providing video outputs representing a wide field of view in the 8 to 12μm IR waveband and a narrow, magnified, field of view in the 3 to 5μm IR waveband. These two video outputs are sent to separate frame stores 2 and 3, the output from each of which is directed to a mixer 4. The resultant video signal, representing output video frames, is passed to a helmet-mounted display 5 providing a head-up display in the line of sight of the wearer of the helmet. The display 5 is provided on the visor 6 of the helmet 7, which carries a head position sensor 8, which may be based on an optical or a magnetic sensor device. Such sensors and their monitoring systems are well-known in the art and will therefore not be described in detail.

The information provided by the head position sensor 8 passes, after suitable processing, to a pair of address modifiers 9 and 10, one for each waveband. These provide signals to the respective frame stores 2 and 3 to output video information in accordance with addresses in the stores which correspond to the position sensed by the head position sensor. In other words, the image displayed by the helmet-mounted display corresponds to the area towards which the wearer of the helmet is looking. Referring to Figure 2 as an example, the field of view covered by the 8 to 12μm sensor is 120° by 80°, and the 3 to 5μm sensor covers a field of view of 25° by 17° at the centre of this. If the wearer of the helmet directs the centre of his gaze away from the centre of the wide field of view, as indicated by turning his head, which is detected by the head-position sensor, the image area passed to the helmet-mounted display is also changed accordingly. The new area, for example as indicated by numeral 20 in Figure 2, covers a part 20a of the wide angle image 21, and a part 20b of the narrow angle image 22. The wearer will see the image in his display accordingly.

CLAIMS

1. A thermal imaging system, comprising a wide angle thermal sensor providing an output signal representing successive image frames, means for temporarily storing information representing each frame in turn, means for superimposing on the field of view of a user an output image frame, means for detecting the position of the user's head and for selecting as the output image frame a portion of the stored image frame according to said detected position.

2. A thermal imaging system, comprising a wide angle thermal sensor and a narrow angle thermal sensor, each providing an output signal representing successive image frames, the field of view of the narrow angle thermal sensor lying within that of the wide angle thermal sensor, means associated with each sensor for temporarily storing information representing each frame in turn, means for superimposing on the field of view of a user an output image frame, means for detecting the position of the user's head and for selecting as the output image frame a portion of one or both of the stored image frames according to said detected position.

3. A thermal imaging system, comprising a wide angle thermal sensor and a narrow angle thermal sensor, each providing an output signal representing successive image frames, the narrow angle thermal sensor having a field of view directable within that of the wide angle thermal sensor,

means associated with each sensor for temporarily storing information representing each frame in turn, means for superimposing on the field of view of a user an output image frame, means for detecting the position of the user's head and for selecting as the output image frame a portion of the stored wide angle image frame according to said detected position, means for selecting as an alternative output image frame a portion of the stored narrow angle image frame according to the detected position, and means for switching between the alternative output image frames.

4. A thermal imaging system according to Claim 3, wherein the means for switching between alternative output image frame comprises means selectively operable to combine the two alternative output image frames into a single output image frame.

5. A thermal imaging system according to Claim 2, 3 or 4, wherein the narrow angle thermal sensor is sensitive to a different waveband to that of the wide angle thermal sensor.

6. A thermal imaging system according to Claim 5, wherein the wide angle thermal sensor operates in the 8 to 12μm waveband and the narrow angle thermal sensor operates in the 3 to 5μm waveband.

7. A thermal imaging system according to any preceding claim, wherein the temporary storage means comprise frame stores.

8. A thermal imaging system according to any preceding claim, wherein the means for superimposing an output image frame on the field of view of a user comprises a helmet-mounted head-up display.

9. A thermal imaging system according to Claim 8, wherein the means for detecting the position of the user's head comprises means mounted on the helmet for providing a position signal to be detected by fixed means located near to the helmet.

10. A thermal imaging system according to Claim 8, wherein the means for detecting the position of the user's head comprises detector means mounted on the helmet for detecting a position signal provided by fixed means located near to the helmet.

11. A thermal imaging system according to Claim 3, wherein the narrow angle thermal sensor comprises steering prisms for directing the field of view of the sensor in accordance with the detected position of the user's head.

12. A thermal imaging system, substantially as described with reference to the drawings.

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| **Patents Act 1977**<br>**Examiner's report to the Comptroller under Section 17 (The Search Report)** | Application number<br>9007955 |

**Relevant Technical fields**

(i) UK Cl (Edition K ) H4F (FAA, FDX, FESA)

(ii) Int Cl (Edition 5 ) H04N

**Search Examiner**

T BERRY

**Databases (see over)**

(i) UK Patent Office

(ii)

**Date of Search**

19 MARCH 1991

**Documents considered relevant following a search in respect of claims**

1 to 12

| Category (see over) | Identity of document and relevant passages | Relevant to claim(s) |
|---|---|---|
| | NONE | |

| Category | Identity of document and relevant passages | Relevant to claim(s) |
|---|---|---|
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